

TOWARD 10-MAS INFRARED ASTROMETRY

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Abstract: This paper will focus on the acquisition and analysis of infrared astrometric data with the U. C. Berkeley Infrared Spatial Interferometer (ISI) on Mt Wilson. Infrared astrometry at the 10-milliarcsecond (mas) level is applicable to experiments in stellar evolution astronomy, solar system dynamics, relativistic gravitation, and deep space laser tracking. In most applications, an infrared reference frame will be needed, which can be tied to the optical, radio, and planetary frames. We are pursuing astrometry with ISI to demonstrate a 10-mas capability for tracking stellar and solar system objects, and for establishing an infrared reference frame with at least that level of stability.

A general requirement on the sensitivity of astrometric devices is that the white (quantum or thermal) noise be low enough to allow integration times short compared to those characteristic of appreciable propagation media effects. F-or interferometric devices, both white noise and low-frequency peaked propagation noise contributions to the phase must be small enough to allow phase connection. Usually rms phase variations <0.1 cycle guarantee reliable phase connection. With data from the Summer and Fall of 1993, we will show that instrumental sensitivity and data acquisition methods allow reliable phase connection for a range of seeing conditions on Mt. Wilson. Once phase is connected, atmospheric fluctuations limit the astrometric performance of ISI.

Analysis strategies will be presented which minimize the effects of dominant atmospheric and instrumental errors. These strategies utilize the helium-neon laser distance interferometer (HeNe LDI) path delays, which reflect the instrumental and atmospheric delay contributions within the instrument. It was found that, on nights with good seeing, large correlations between the HeNe LDI and stellar path length fluctuations suggest an approximate atmospheric turbulent height of 25 meters. Optimal application of the HeNe LDI delays to the infrared fluctuations requires an assessment of the spatial and temporal statistics of atmospheric and instrumental fluctuations. A least-squares estimator of interferometric phase has been developed to minimize errors from atmospheric propagation and resonances detected in the phase data. The resulting astrometric accuracies have been calculated to be at the 6-10 mas level. We will present single-star ISI data which show internal consistency at this level.

Once single-star astrometric performance is at the 10 mas level, the relative positions of two stars must be determined by measuring the interferometric delay difference between them. Instrumental and atmospheric issues in resolving cycle ambiguities between stars will be discussed. Acquisition and analysis strategies for relative star ambiguity resolution will be described and demonstrated with the ISI 1993 data,

Brief Biography. R. N. Treuhaft has a B.S. in physics (1976) from Yale University, and a in high energy nuclear physics (1982) from U. C. Berkeley. He has worked at the Jet Propulsion laboratory since 1982 as a member of the technical staff, Radio Metric Technology Development project manager, and technical supervisor of the Astrometric Techniques Group. His publications are on the limiting, particularly atmospheric, errors of radio astrometry and demonstrations of high-accuracy radio astrometric techniques for relativistic deflection.